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Mill Creek Units 1&2
Gas Co-Firing

1/31/2020

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Mill Creek Units 1 and 2 Gas Co-firing

Executive Summary

In anticipation of future regulatory requirements to reduce NOx emissions in Jefferson County, the company has undertaken a review of the technologies available for Mill Creek Units 1 and 2 NOx reduction. Black & Veatch reviewed ten technologies and reported on economics and feasibility in their report provided in Appendix A.

House Joint Resolution 8, House Bill Request 808, is currently in committee and requires a cost-benefit analysis of reformulated gasoline (RFG) and equivalent environmental offsets in Jefferson County. Theoretically, LG&E could net out the emissions benefits of RFG with NOx reductions at Mill Creek Units 1 and 2. This would require an estimated 0.35 ton per day reduction in NOx emissions, or 2.5% of the current emissions at Mill Creek 1 and 2. The most economic technology for NOx reduction at Mill Creek 1 and 2 is gas-cofiring using existing equipment. This would result in an estimated 3-5% (0.42-0.71 tpd) reduction in NOx. The additional fuel expense during the ozone season is ~$2.5 million per year.

A thermal study and full-scale test of gas co-firing at 10% heat input is recommended to verify the operation and maintenance impacts on the units.

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1.0 Reformulated Gasoline Offset

In order to offset the emissions benefit of RFG in Jefferson County, a reduction in NOx emissions of 0.35 tons per day is required. To achieve this reduction at Mill Creek Units 1 and 2, including a reduction factor of 1.15 and operating margin, approximately 3% NOx reduction would be required. While the exact impact of gas co-firing at low levels is unknown, it is estimated that a 10% gas co-firing rate (BTU basis) would achieve a 3-6% NOx reduction. *A test burn is recommended to demonstrate the ability to sustain this low NOx reduction level. Normal variability in operating conditions may have a significant impact on the sustainable average NOx reduction.*

1.1 Availability of Natural Gas

In 2016, a request was submitted to LG&E Gas Distribution regarding gas supply capacity to the Mill Creek Station. Recently, LG&E Gas Distribution provided confirmation that there have been no changes to the equipment that would impact capacity.

The gas supply to Mill Creek Station is designed to provide gas at 100 psig from either the LG&E Western Kentucky or Magnolia gas transmission pipelines. The maximum capacity of the gas measurement equipment at the lowest inlet gas transmission pressure is approximately 1,327 Mcfh. By changing the orifice plate sizes in the 8" orifice fittings, the capacity can be increased to approximately 2,400 Mcfh. The gas regulation equipment capacity at the lowest inlet gas transmission pressure is approximately 3,000 Mcfh.

Mill Creek Units 1 and 2 would require approximately 300 Mcfh of natural gas each to reach 10% heat input from natural gas. If further NOx reduction was required in the future, 900 Mcfh of gas per unit to reach 30% heat input would be required. The current system is capable of supporting gas-cofiring at 10% for both units. Mill Creek load is currently modeled at 690 Mcfh for gas system planning and per gas supply contracts.

It should also be noted that additional discussions will be necessary to evaluate the potential need for gas during start-up and stabilization on Mill Creek 3 and 4 while simultaneously co-firing on units 1 and 2.

1.2 Cost Impacts of Co-firing Natural Gas

The fuel cost impact of co-firing 10% natural gas is estimated at $2.5 million for both units based on 2020 ozone season (May – September) projections. Generation Planning provided the monthly fuel burn rate in MMBtu for Mill Creek 1 and 2, and the monthly delivered fuel cost for coal and natural gas ($/MMBtu). Average values for the ozone season months were employed for the calculation of fuel cost impact.

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2020 Ozone Season Fuel Costs	
Cost for Coal ($/MMBTU)	$2.05
Cost for Gas ($/MMBTU) - LGE	$3.61

2020 Ozone Season Gas Co-Firing Costs			
	Unit 1	Unit 2	Total
Heat input (MMBTU)	8,185,600	7,950,700	16,136,300
Cost of Fuel Burning 100% Coal	$ 16,780,480	$ 16,298,935	$ 33,079,415
Cost of 90/10 Burn - LGE Gas	$ 18,057,434	$ 17,539,244	$ 35,596,678
Delta in Fuel Cost (100% Coal vs 90/10 LGE Gas)	$ 1,276,954	$ 1,240,309	$ 2,517,263

2.0 Historic Evaluation of Gas Co-Firing Capability at Mill Creek Units 1 and 2

In 2012, a VISTA analysis of gas co-firing at Mill Creek was completed by Generation Engineering. This study will be updated to reflect changes to the unit equipment since 2012. A revision to this report will be provided upon completion of the VISTA analysis which will employ recently updated Mill Creek 1 and 2 models. The goal of this analysis is to predict the attainable level of gas co-firing without boiler surface area modifications and to evaluate operation and maintenance impacts of co-firing natural gas at various heat input levels.

In 2016, Mill Creek personnel completed a review of the gas co-firing capabilities of Units 1 and 2. The review determined what level of gas co-firing was feasible without major modifications to the units and estimated costs for a detailed engineering study by GE Power to determine the modifications required to burn gas at percentages higher than the current capacity, up to 100% natural gas. The results of this analysis are reiterated herein. A full-scale test of natural gas co-firing with existing equipment was planned but not executed.

In 2016, Generation Planning and Generation Engineering contracted with Black & Veatch to evaluate NOx reduction options for the Mill Creek Units 1 and 2. This study report is provided in Appendix A.

2.1 Current Gas Co-Firing Capacity at Mill Creek Units 1 and 2

Mill Creek Units 1 and 2 currently employ natural gas for startup and coal flame stabilization. There are eight gas ignitors and eight warm-up guns. These burners are sized for approximately 8-10% of full load heat input.

2.2 Mill Creek Synopsis of Co-firing Feasibility

Mill Creek Units 1 and 2 already have natural gas warm-up elevations in the auxiliary air AB and CD elevations. These are sized for about 10% of full load heat input – in other words, they satisfy the criteria for of Class I ignitors for the associated coal elevations. To achieve a 30% rating, the existing gas spuds would need to be resized to accommodate the additional gas flow. This will require a natural gas piping system review with the sizing dependent on the gas supply pressure and the desired pressure at the gas nozzles. As part of this operational change, other areas for review and verification would include: the fuel master and gas firing combustion control logic and burner management system (BMS) logic; the sizing of the various fuel/air compartments to ensure proper combustion air distribution; and the thermal performance (steam temperatures and spray flow rates) of the boiler to ensure the unit will still perform at the desired level without degrading life of the equipment.

2.3 B&V Study Synopsis

The B&V study report (Appendix A) addresses various technologies for NOx reduction at Mill Creek 1 and 2. Natural gas co-firing was evaluated, and the analysis is similar to the Mill Creek review. Additional key points identified are:

- improved unit turndown
- 40% co-firing typically does not require boiler and auxiliary modifications
- reduction in heat transfer resulting in lower steaming capacity - can be offset by increased heat input, which will increase finishing steam temperatures and exit flue gas temperatures

Due to the changes in heat transfer characteristics, a thermal model and combustion and heat transfer study would be prudent. Evaluation of the natural gas piping system would also be needed.

3.0 Conclusions and Recommendations

Natural gas co-firing at approximately 10% of heat input at Mill Creek Units 1 and 2 is feasible and would reduce NOx emissions by 3-5% (0.42-0.71 tpd). Theoretically, this reduction could net out the emissions benefit of reformulated gasoline in Jefferson County. The fuel cost increase would be approximately $2.5 million per ozone season, plus a potential increase in maintenance costs. Estimating the maintenance cost impacts requires a more detailed study of the operational impacts of gas co-firing.

A full-scale test of gas co-firing at the maximum currently attainable level with existing equipment is recommended in order to better understand the long-term impacts of the change in fuel source mix. Thermal impacts should be modeled and evaluated to determine the impacts of gas co-firing at levels greater than 10%.

It is recommended that additional discussions be held to evaluate the potential need for gas startup fuel or stabilization on Mill Creek 3 and 4 simultaneous to co-firing at units 1 and 2.

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Appendix A

B&V NOx Reduction Study Project Report

LGE-KU NOx Reduction Study...